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Wrapped in plastic

Our recycling series arrives at the issue of synthetic polymers—the plastics in which our planet is slowly drowning. Jodie Lea Martire takes a deep breath.

It's hard to be melodramatic about plastic's impact on our planet. From the birth of semi-synthetic plastics with celluloid in 1856, to the first fully synthetic plastic (Bakelite) in 1907, through rapid growth in the 1950s up to today, our species has created over 8.16 billion tonnes of plastic in less than 200 years.

Only 9% of that plastic has ever been recycled—of the rest, if it's not polluting our oceans or our streets, or been incinerated to darken our skies, it has gone into landfill. And every single one of those pieces is still there, contaminating land, water, atmosphere and living beings.

Remarkably, the percentage of plastic that gets recycled today matches up almost exactly with the percentage that's ever been recycled: every year, 90.5% of plastics go unrecycled. Just 2% are recycled into a similar product, while 7% to 8% become lower-quality items. Everything else goes to landfill, is leaked into nature or is burned.

The future looks no better. At current rates, plastic's greenhouse-gas emissions could reach 1.36 billion tonnes per year. Plastic is a by-product of fossil fuels, and the devastating persistence of the oil and gas industries, along with their investment in the plastics industry, has WWF claiming "plastic production is likely to double by 2040, and plastic pollution could triple by 2040".

Insiders say Big Fuel is eyeing off plastic production to compensate for their declining fuel market (thanks, climate activism!). They tend to greenwash their plastic products by pushing plastic's infinite recyclability—a benefit that's all very well in theory, but never actually achieved in reality.

In 2019, 4% to 8% of the world's annual oil consumption fed the plastics industry. A recent report from Yale Climate Connections estimates that this figure will rise to 20% by 2050—and the Center for International Environmental Law (CIEL) estimates that by 2100, plastic production will account for over 50% of the world's carbon budget.

Our oceans already hold 168m tonnes of plastic waste, and that figure is growing by almost 10m tonnes per year. An estimated 14m tonnes of microplastics—an often underdiscussed problem that we examined in *Renew* 155—lie on the sea floor, eventually making their way into the food chain of over 700 marine species and their predators (like whales, albatrosses and humans). These particles are *everywhere*. They've even been found deep in the Mariana Trench, the deepest point of which—at over 10km below the surface of the ocean—is the single deepest oceanic trench on Earth.

Even plastics that we believe we've done the right thing with and "recycled" often end up in the seas surrounding countries that import waste, releasing greenhouse gases as they degrade. On current trends, there will be more plastic than fish in the seas by 2050, with the most destructive varieties to marine life being fishing debris, plastic bags, balloons and plastic utensils.

And yet, here we are in 2021, with plastics



A pretty bleak portrait of how long various plastic items hang around in the environment.

Image: © WWF-Australia

so deeply embedded in every industry and product that modern life is impossible without them. Since recycling is one of the few sane responses left—after refusing, reducing and reusing plastics—let's see how Australia looks through a plastic lens.

How is plastic recycled?

There are many different types of plastic, but at the most basic level, they are all variations on a theme: long-chained, carbon-based polymers. This means that in theory, all plastics can be recycled. However, that fact doesn't mean our current systems necessarily allow for recycling any given plastic—and in many cases, they don't. (This is discussed in "Which plastics can be recycled?" below.)

It's also important to understand that plastic *can't* be recycled infinitely. With each reincarnation, it loses a little stability and integrity, and needs more virgin materials to

keep its original quality.

Most plastics are collected through plastic or mixed recycling bins. Once collected, the plastics are screened, sorted by colour and/or material, baled and taken to processing plants to be mechanically recycled.

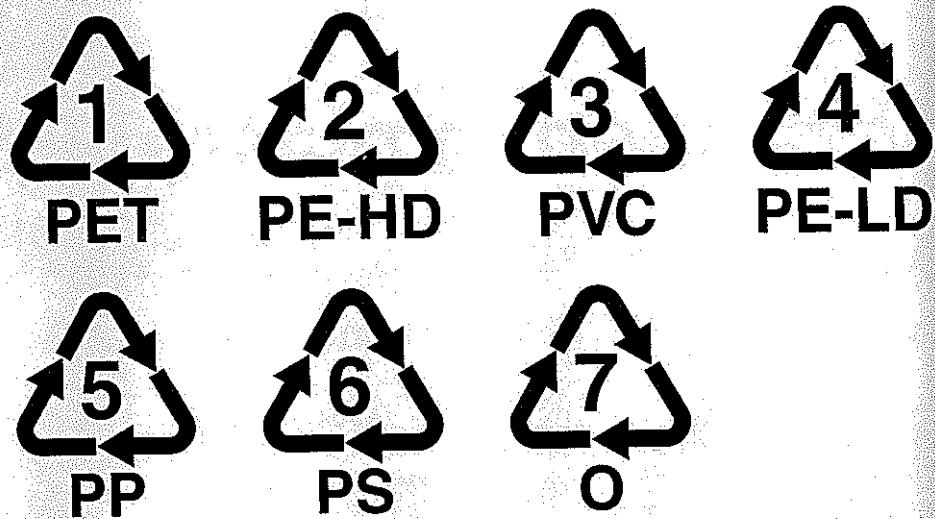
At a recycling plant, plastics are first washed and decontaminated, and any stray metal is extracted using magnets. Once it's ready to be recycled, the plastic is "compounded"—it's shredded into flakes and melted, then fed through a machine called an extruder (which is basically like a plastic mincer). The plastic is then cooled, pressed into dies, and chopped or pelletised into granules for refabrication. (You can also DIY-recycle your plastic this way using Precious Plastic's machine blueprints—there's a link in the Resources section!)

In addition to the above process, plastics can also go through "advanced recycling", where chemicals are used to break a plastic's polymer chains down into their constituent monomers. These monomers can then be refabricated.

Australia has taken a sudden interest in these processes in the wake of China's 2017 decision that it no longer wanted to be the dumping ground for the world's plastic waste: in August 2021, the CSIRO released a report entitled *Advanced recycling technologies to address Australia's plastic waste*, which explores... well, the title says it all, really.

The report is worth reading, and gives a detailed overview of various chemical processes, which plastics they can be applied to, and what the resulting monomers can be used for. While some feedstocks (for example, PET) can be broken down and then reassembled into the original plastic, others are less co-operative. PVC, for instance, yields hydrogen chloride (which, in water, is hydrochloric acid), benzene and/or toluene. None of these are much use as plastics, and are thus generally sold off to the chemical industry.

There are also "conversion" processes, which refer to decomposing the plastic right back down into the fossil fuels from which it came: pyrolysis reverts plastic feedstock into crude oil, while gasification converts it into, you guessed it, gas for fuel.



The seven Resin Identifier Codes (RICs) you'll find on the vast majority of plastic items. Spoiler: the recycling triangle doesn't necessarily mean they're recyclable.

Image: Lubo Ivanko/iStockPhoto

Another approach is purification, which basically involves dissolving a plastic in a suitable solvent; removing any impurities, contaminants, etc; and then precipitating out the original plastic in a (hopefully) pure form. And finally, as a last resort, energy can be recovered from waste plastics by incinerating them. This option is not recommended—the world has enough toxic substances in its atmosphere already, cheers.

Which plastics can be recycled?

To know whether you can recycle a plastic item, first look at the "Resin Identifier Code" (or RIC—see the diagram on this page). If you see one of these, with its nice, easy-to-understand recycling symbol, you can rest assured that... the item is not necessarily recyclable. Wait, what?

Yes, that triangle sure looks like the recycling symbol, but these labels were actually created by the plastics industry. To overcome (entirely understandable) consumer misunderstandings, the Australian Packaging Covenant Organisation (APCO) launched the Australasian Recycling Label (ARL) in 2018. It has since been authorised by all Australian governments and is due to be on 80% of supermarket products by December 2023.

In the meantime, though, the RIC continues to be ubiquitous, so let's run through what its seven symbols mean. A good rule of thumb is that plastics 1 through 4 are "thermoplastics", which can be melted and remoulded, but 5 and 6 are "thermosets" or cross-linked polymers that cannot easily be separated and recycled. The labels break down (no pun intended) in more detail as follows:

1. Polyethylene terephthalate, or PET. (You may remember it from the "Pete Repeat" ad campaigns of the 1990s.) As far as plastics go, this is a winner: it's relatively easy to recycle, both mechanically and chemically.
2. High-density polyethylene, or HDPE. Recycled mechanically. Also used for gasification, pyrolysis and other conversion.
3. Polyvinyl chloride, or PVC. Difficult to recycle; as a result, some councils won't touch it (see below) and some recyclers consider it a contaminant.
4. Low-density polyethylene, or LDPE. Can be recycled mechanically if clean; otherwise, it's into the conversion queue.
5. Polypropylene, or PP. Hard to recycle, but can be purified or earmarked for conversion.

Top tips for reducing plastic waste

- Buy food and household products from a zero-waste or wholefood shop (take your own containers and fill them up—time and again);
- Use biodegradable or compostable bags—for food, dog poo and whatever else you can;
- Learn to recognise the Australasian Recycling Label (ARL), the seven RIC symbols on p42, the double-arrow logo showing something is home compostable, and the seedling label for certified compostable goods;
- Cold-rinse your plastics, crush bottles and containers, and put the lids back on so they don't get lost;
- Remember your shopping bag and reuse it for as long as possible;
- Say no to straws, plastic cutlery and any excess plastic packaging;
- Carry your own reusable coffee cup (plus a reusable straw and cutlery if you can); and
- Only buy loose fruit and vegetables.

6. Polystyrene, or PS. Did excellent work in '70s punk pioneers X-Ray Spex. The CSIRO call it an "excellent candidate for purification technologies", but it's generally recycled only at specialist facilities.
7. Other. A catch-all category for basically everything else that's a plastic but isn't one of the above. If it's in this category, chances are it's not recyclable.

In addition to the confusion about what's recyclable and what isn't, not all RICs can be placed into municipal recycling bins. Hard plastics coded 1, 2 and 5 go in most council bins, but double-check codes 3, 4, 6 and 7: as of late 2019, plastics 4, 5 and 6 were not collected by 50% of Queensland councils, or a third of those in NSW, SA and Tasmania.

And, in yet another wrinkle, while a given plastic may be recyclable in theory, the nature of the item also matters. Plastic bags, normally

made of high-density polyethylene (HDPE or number 2) or low-density polyethylene (LDPE or number 4), simply obstruct and contaminate the recycling process. Recycling workers don't have time to open plastic bags to see if they contain recyclables, so the whole bag gets landfilled unopened.

These "scrunchable" soft plastics also come as biscuit packets, vegetable bags, plastic film and magazine wrapping. Only a handful of councils accept soft plastics kerbside. Despite plastic-bag bans operating across the country (except NSW, whose ban comes online in 2022), Australians use 3.9 billion checkout bags a year and over 200,000 of them hit landfill every hour. Only 3% are recycled at all.

Surely we're done with the caveats now? Nope. Not even close, sadly:

- Black plastics—like those used in meat trays, coffee pods and pot plants—are hard to recycle as they don't reflect light. This means the optical scanners at recycling facilities can't identify their composition;
- Coffee cups aren't mainstream recyclable as they're a combination of plastic and paper (like the demon Pringles container) but check out Simply Cups and its roadwork projects (in *Renew* 153);
- Small single-use plastics like straws, lid and cutlery are yet to be banned Australia-wide, and often fall through the cracks of recycling systems—of the 1m tonnes we use each year, some can be recycled, but most aren't;
- Lego recycles its own pieces and aims to shift to bioplastics by 2030, but for now needs specialist systems;
- Nespresso does the same with coffee pods while other coffee companies use TerraCycle (see below) as their recycling partner;
- Avoid recycling bubble wrap; and
- Please, please, *please* don't put nappies in the recycling. No-one will thank you for it.

And then, there's ... bioplastics

There is one rabbit hole this article will point at rather than fall into: bioplastics. For full details on how "environmental" they are, see *Renew* 152—but here's a point-by-point summary:

- Yes, bioPE or bioPET can be recycled with traditional plastic, but otherwise separate systems are required;
- So-called "degradable" plastics are a myth: sure, the plastic disintegrates when exposed to light and heat, but what it disintegrates into is smaller pieces of the same plastic, which are more contaminating for both animals and waterways;
- Bioplastics can be labelled as "biodegradable" or "compostable", in which case they'll be made from PLA (polylactic acid, from starches like corn or cassava), or PHA (polyhydroxyalcanoate, from microorganisms that generate plastic from organics). Biodegradable or "oxodegradable" items use those microorganisms to make them break down into tiny pieces, but again, they create landfill; and
- "Compostable" plastics are made of plant starches, creating a more expensive material that needs commercial composting systems to break down correctly. In landfill they lack the oxygen and water needed to return to nature (although some claim to be home compostable). To be legally compostable, they must meet Australian Standard AS4736 and have the leaf symbol. The more "compostable" plastics are, of course, the fewer purposes they can serve compared to fossil plastics.

What are the benefits of recycling plastic?

First and foremost, recycling plastics reduces fossil fuel consumption and greenhouse gas emissions, both of which are lethal to Planet Earth. For example, each kilogram of virgin PET emits 2.5kg of CO₂ in its production, compared to 1.6kg CO₂ in its recycling. HDPE drops from 2.1kg CO₂ (virgin) to 1.3kg CO₂ (recycled).

Recycling also reduces plastic pollution, insofar as it involves reusing material that would otherwise end up being released into the environment. This is important, because plastic also has a loooong lifecycle: water bottles, coffee pods, plastic cups and six-pack rings are all predicted to survive for around 500 years. Greenhouse gases are emitted at every stage of plastic's life: fuel extraction and

transport, refining and manufacture, waste management, and once returned to our lands and waters. According to WWF, we ingest an average of 2000 tiny pieces of plastic a week, adding up to the weight of a credit card.

Are there drawbacks to replacing and recycling plastic?

The major issue with recycling is that the plastic problem is simply too big for recycling alone—and the reason our problem is so big is because plastic has long been considered a "good" product. Its primary source materials have long been cheap, abundant and well distributed; it's cheap and energy efficient to produce; and it's lightweight, which reduces transport costs and energy use. In addition to these properties, it's also versatile, strong and shatterproof, as well as being effective for packaging, food safety, scientific and medical uses. That's a high bar for alternatives.

Another problem is the lack of suitable facilities to recycle plastic reliably, along with a lack of re-manufacturers who can create products from recycled plastics. Ideally, such plants should be physically close to each other, to avoid transport costs that will push up the recycled materials' price. In addition, the price of recycled raw plastics can stymie the industry's willingness to recycle, as it's often not enough to compete with the shamefully low price of fossil plastics. In other words, with fossil-fuel subsidies continuing to drive filthy industries, it's often cheaper to make new plastic than recycle the old.

There's also the vexed question of whether, despite their many environmental drawbacks, plastics may still be more environmentally friendly over the long haul than reusing paper, fabric or metal. While it is counter-intuitive, some life-cycle assessments (LCAs) have found the use of plastics to be better than that of other materials—even in cases like reusing food storage containers (because of hot-water washing and heavy metals in water supplies). Other scientists, however, have criticised these LCAs for not taking into account the continued greenhouse-gas emissions from plastic litter.

All this makes it incredibly difficult to know what to do at a personal level. Our view is that the best (imperfect) trick is to

refuse plastic and reuse your replacement consistently.

How do we recycle plastic in Australia?

Australia uses the same mechanical recycling systems as elsewhere, complemented by systems that bring plastics back into circulation. Soft plastics can be dropped back to most supermarkets in Australia—but only 22% of Australians know this system exists! REDcycle collects from 830 supermarkets Australia-wide, processing plastic and "green" bags before shipping them to organisations like Replas (below).

Other collectors include CurbCycle, which collects soft plastics from your kerbside, and systems like TerraCycle, which aim to collect and recycle all plastics in one bin, including toys and coffee pods. [*Also: for the love of god, stop using coffee pods! —Ed.*] They also recycle plastic-based facemasks.

Victoria-based Replas converts soft plastics into park furniture, garden supplies, high-quality asphalt, fitness circuits, bollards, signage and much more, all while using around 25% of the energy needed for virgin plastic. Other similar outputs include eWood gardening beds (by Newtecpoly), outdoor decking (APR Composites), mini wheel stops (Plastic Forests, Close the Loop) and detergent or drink bottles (Unilever, Visy).

Other ideas include soft fall for playgrounds—which, to anyone who remembers tanbark, must be a whole new world for today's kids—along with wheelie bins, pipes, mud flaps, traffic equipment, water-meter covers, worm farms and compost bins. Australian Recycled Plastics in Narrabri, NSW, both recycles and manufactures HDPE, PET and coloured plastic, and another high-profile all-in-one system is the Albury-Wondonga plant (Cleanaway, Pact Group, Coca-Cola and Asahi) which aims to close the loop on 1m PET bottles each year.

In more innovative solutions, Australian company Licella has developed a technology called a Catalytic Hydrothermal Reactor (Cat-HTR), which uses high-pressure water streams to create recycled oil from plastics in 20 minutes. It functions with all kinds of plastics, which don't need to be separated for type or colour.

Woolworths Australia has entered into a two-year partnership with the Australian National University, CSIRO and company Samsara to trial a commercial plastic recycling plant where enzymes "eat" PET plastic and polyester fabric, reducing it to its core molecules and remaking it as Woolies packaging. A NSW company, Integrated Green Energy Solutions, also converted plastics into diesels and petroliums, but unfortunately was liquidated in 2021.

Despite all this, only 13% of Australia's plastic is recycled, while 84% is sent to landfill. We used 3.5m tonnes of plastic in 2018-19, of which 130,000 tonnes leaked into the oceans around us. As a nation we lose around \$419m each year that we don't recycle all our PET and HDPE plastics (see plastic types on p42), while the cost of plastic's economic damage and threats to wildlife is \$17 billion per annum.

We aren't a country that "mismanages" its plastic waste—the OECD listed China as the world's worst on 2010 figures—but we sure aren't Norway, which recycles 90% of its PET bottles. And speaking of China, up until it announced its National Sword Policy in 2017, which started banning international recycling exports, plastics were one of the major problems we shipped abroad—125Kt in 2016-17, to be precise.

Since the National Sword amputated the option of continuing to ship this problem offshore, Australia has set itself key plastic recycling targets. Exports of all mixed-waste plastics have been banned since July 2021, a move claimed as a "world first" by the Federal Government. Unfortunately, the industry apparently wasn't ready for this deadline, a problem that may lead to dangerous stockpiling and eventual landfilling of recyclable plastics. For another 12 months, businesses can sort and export their plastics as individual polymers, provided they have a license, but this option terminates in July 2022. From then, only re-processed plastics (e.g. flaked or pelletised recycled plastic) can be exported.

This deadline will cause increased pressure when combined with the 2025 National Packaging Targets, overseen by APCO. These targets apply to all packaging

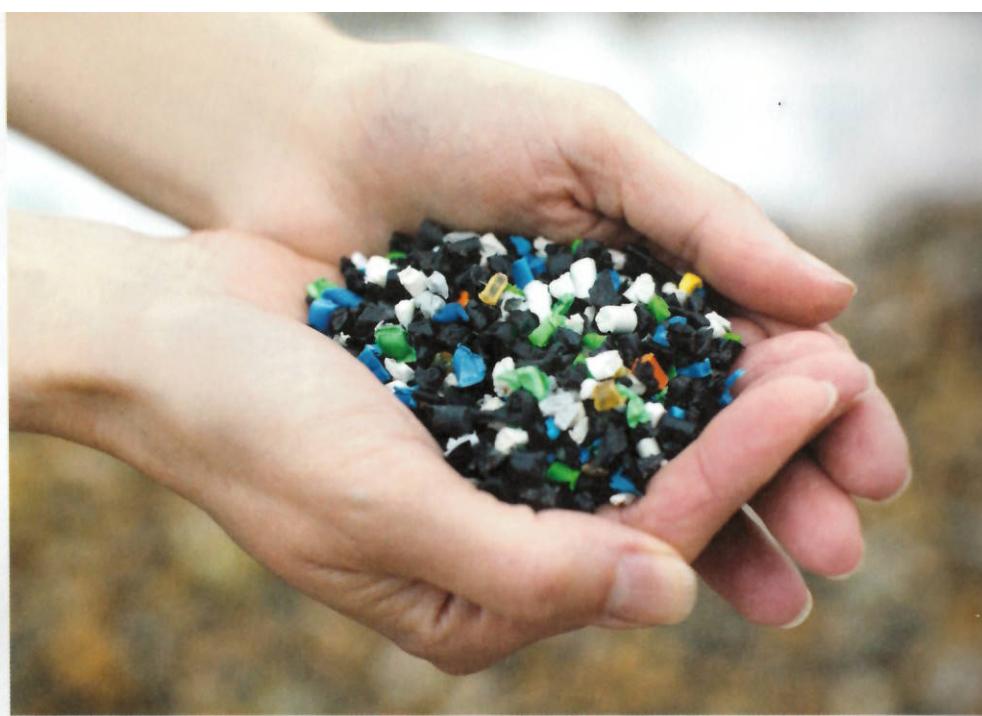
made, used and sold in Australia, requiring it all to be reusable, recyclable or compostable by 2025. In addition, all packaging must have an average of 50% recycled content, 70% of plastic packaging must be recycled, and "problematic and unnecessary" single-use plastics must be phased out. This is all quite the ask: for 2018-19, APCO reported that only 89% of plastics were recyclable, average recycled content was 38% and plastic packaging recycling stood at 18% overall (although 36% for PET and 23% for HDPE).

But, while we have an apparently unprepared industry and a bunch of very ambitious packaging targets, we also have... a plan! Specifically, we have the freshly minted National Plastics Plan, supported by a flurry of new government webpages on plastics. According to the Department of Agriculture, Water and the Environment's contribution to this online onslaught, we are now on a "plastics mission". This mission aims to address source issues of production and leakage into the environment, boost recycling capacity, improve council recycling systems, address waterway pollution and develop data collection, analysis and research processes including a national environmental science program. This all sounds logical, appropriate—and well-and-truly overdue in 2021.

The CSIRO is also all missioned up—it's on a "mission in development" to achieve an 80% reduction in plastics entering the environment by 2030. Its *Circular economy roadmap for plastics, glass, paper and tyres* (January 2021) emphasises the need for improved design, consumption and collection; improved reprocessing capacity and boosted end-markets; and consistency and capability across the Australian systems to support a circular economy. This paper was followed by the aforementioned August 2021 report *Advanced recycling technologies to address Australia's plastic waste*, which pushes to diversify our advanced recycling capacities in order to meet these ambitious targets.

How can Australia improve?

If Australia manages to fulfill its commitments in the National Plastics Plan, following CSIRO's guidance, our plastics



A beachgoer holds an assortment of pieces of plastic, all worn smooth as sand by the ocean—a scene as weirdly poetic as its contents are lethal to marine life.

Image: Daisy-Daisy/iStockPhoto

landscape will already be considerably improved by 2025. But to get there, the system needs education, investment, standards, regulation, product stewardship and meaningful commitment to a plastic-free future.

Even mining/agriculture gazillionaire Andrew "Twigg" Forrest has suggested that there should be "a voluntary industry contribution for new fossil fuel-based plastic production"—that is, a levy on production to fund new recycling technologies, repair environmental damage and assist the industry's transition. It is hard to believe that our fossil-fuel worshipping parliament would maintain these commitments, given the impact they'd have on the bottom line of the coal, oil and gas giants who just won the battle (and possibly the climate war) at COP26.

Perhaps the Australian government should follow the lead of the signatories of the Australia, New Zealand and Pacific Islands Plastic Pact, where 60 local businesses have joined over 500 others worldwide to meet targets similar to (but lower than) APCO's 2025 Targets. Another option is a private-public collaboration, like the National Plastic Action Partnership applied at a national level in Indonesia. Or, a meaningful step would be signing a proposed global, legally binding plastics treaty, which hopefully will enter discussions at the UN in February 2022.

Clearly what is needed is an integrated response that addresses all stages of the plastic lifecycle. The Center for International Environmental Law issued a scathing report

in 2019 on the relationship between plastics and climate change. Their five top solutions that would cut CO₂e emissions and support social and environmental benefits were to end production and use of single-use plastics; stop development of new fossil-fuel infrastructure; promote zero-waste communities; establish extended producer responsibility; and adopt and enforce industry-wide targets to reduce greenhouse-gas emissions. By following this guidance as well as the plans Australia has already adopted, we might just manage to not make it a single-use planet. ¹

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RESOURCES:

Recycling Near You (plastic bottles/containers) recyclingnearyou.com.au/plastic

Recycling Near You (soft plastics) recyclingnearyou.com.au/soft-plastics

REDCycle redcycle.net.au/what-to-redcycle/

Australasian Recycling Label arl.org.au

Precious Plastic DIY recycling machines bit.ly/3ei7QBA



Case study: ReCo

ReCo is a new company with a small name and a big ambition. The name abbreviates the phrase "re-imagine and co-create" and the company aims to assist Sydney's transition to a circular economy. ReCo is driven by the hard realities of climate damage, like the fact—demonstrated in the Ellen MacArthur Foundation's report *Completing the Picture*—that 45% of global greenhouse-gas emissions comes from making and using products and food. In response, ReCo has developed a business whose very methodology counteracts that take-make-waste system—and helps Sydneysiders cut the Gordian knot of plastic production and pollution.

ReCo is proud to call itself a "hyperlocal" enterprise, and since 2020 it has been operating a "refill delivery service to help Sydney's residents and businesses cut down their plastic waste and carbon footprint". Its process is very simple: you order green cleaning products from ReCo's website, and ReCo then delivers a 1kg reusable glass jar to your door. In three months or so when it's empty, you reorder and ReCo swaps your empty jar for a new one, plus gives you a \$2 reward.

"Our biggest challenge," says co-founder Anett Petrovics, "was how the whole system was going to work. But people adapted to it very quickly, and customers only forgot to put their jars out for collection twice." Danling Xiao, Anett's partner in life and business, adds, "The glass has been kept very, very well. Only twice customers have broken it." Impressively, 75% of ReCo's customers are returning for refills.

Danling and Anett run the business day-to-day, making sure they do a delivery run once a week to get away from the computer screen. Elsewhere in the city, they work with other team members and also use Pack'n'Send to run delivery hubs. They're aware that glass's weight adds to fuel costs in transport,

which is why they try to deliver as "hyperlocally" as possible to businesses and households. So far ReCo is only supplying two products, laundry and dishwasher powders made by SimplyClean in the NSW Northern Rivers. It plans to expand its stock lines to other Australian brands and products.

By developing a business around reusable packaging, Danling says, "you never throw things into the recycling again." She continues, "Nothing needs to go through physical or chemical transformations that cost energy, to make products that need to be transported. We are able to retain the glass packaging within our system." And while ReCo hasn't had the breakages or system failures that seem like obvious issues, Anett and Danling do recognise that their model makes it hard to scale the business up while sticking to their principles. However, by aiming to establish itself locally first, in a way that creates minimal waste and emissions, ReCo hopes to inspire behavioural changes at scale—and thus make it easier for Sydney's residents to live in a circular economy.

As Anett says, "So many people are doing an amazing job on a local and a global scale—



(Above) ReCo founders Danling Xiao (left) and Anett Petrovics; (top) still life with cleaning products.

Images: Jason de Plater / ReCo

making sure resources are put back in the system to be used. We need a lot of actions to be taken right now, and we're really proud to be part of these solutions." — *Jodie Lea Martire*